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Physics 30X
Aug., 1969

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HIGH SCHOOL AND UNIVERSITY MATRICULATION

EXAMINATIONS BOARD

**DEPARTMENTAL EXAMINATIONS, 1969**
**AUGUST**

# PHYSICS 30X

Time — 2 hours.

Total Possible Mark — 126.

To ensure accuracy in the handling of your examination papers, the following sections on your ANSWER SHEET MUST BE COMPLETED.

SECTION A — Supply information as requested.

SECTION B — Labels will not be provided for the August examinations. Therefore disregard the box re label.
Indicate your name, mailing address and birth date in the space provided.

SECTION C — Supply information as requested.

SECTION D — Disregard this section.

Questions 1 to 45 are multiple choice questions and are to be recorded on the separate ANSWER SHEET provided. These questions are valued at 2 marks each.

Your score in this section is the number of correct answers you give. If a question seems to be too difficult, make the most careful guess you can, rather than waste time puzzling over it.

Questions 46 - 52 must be done in this booklet.

inished work in this booklet must be done in pencil or blue or black ink (pen or ballpoint).

OTE — Mathematical tables will be supplied by the Presiding Examiner.
Slide rules may be used.

Use the following constants where they are required:

$g = 10 \text{ m/sec}^2$
1 calorie = 4.2 joules
1 coulomb $= 6.2 \times 10^{18}$ elem. ch.
1 volt $= 1.6 \times 10^{-19}$ joules/elem. ch.
Constant in Coulomb's Law:

$$k = 2.3 \times 10^{-28} \frac{\text{newton} - \text{m}^2}{(\text{elem. ch.})^2}$$

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OT FOLD EITHER THE ANSWER SHEET OR THE TEST BOOKLET.

Place your answer sheet **BEHIND** the test booklet and **INSERT BOTH IN THE SAME ANSWER ENVELOPE** in such a way that the **UPPER LEFT-HAND CORNER OF THE BOOKLET** (Candidate's Number) shows through the **SLASHED CORNER** of the answer envelope.

BE SURE TO SEAL THE ENVELOPE.

| |
|---|
| Machine Score |
| Book Score |
| TOTAL |

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Questions 1 - 45 are to be machine scored. You are to record your answers on the separate answer sheet which will be provided. Each question has four suggested answers. Select the best answer and record it on the separate ANSWER SHEET, as shown in the example below.

| EXAMPLE | ANSWERS | ANSWER SHEET |
|---|---|---|
| A body moves at the rate of 4.0 m/sec. How far will it travel in 10 sec? | A. 20 m<br>B. 40 m<br>C. 60 m<br>D. 80 m | A ☐ B ■ C ☐ D ☐ E ☐<br>DISREGARD COLUMN "E" ON ANSWER SHEET |

You are to use an ORDINARY HB PENCIL to mark your answers on the ANSWER SHEET. Make certain your answer marks are heavy and black and that they do not extend beyond the guide lines. If you change your mind about an answer, be sure to erase your first mark completely. There should be only one answer marked for each question. Be sure there are no stray pencil marks on your answer sheet.

**1.** What is the order of magnitude of the number 60,000?

**1.** A. $10^4$
B. 5
C. $10^5$
D. 6

$6 \times 10^5$ 60000

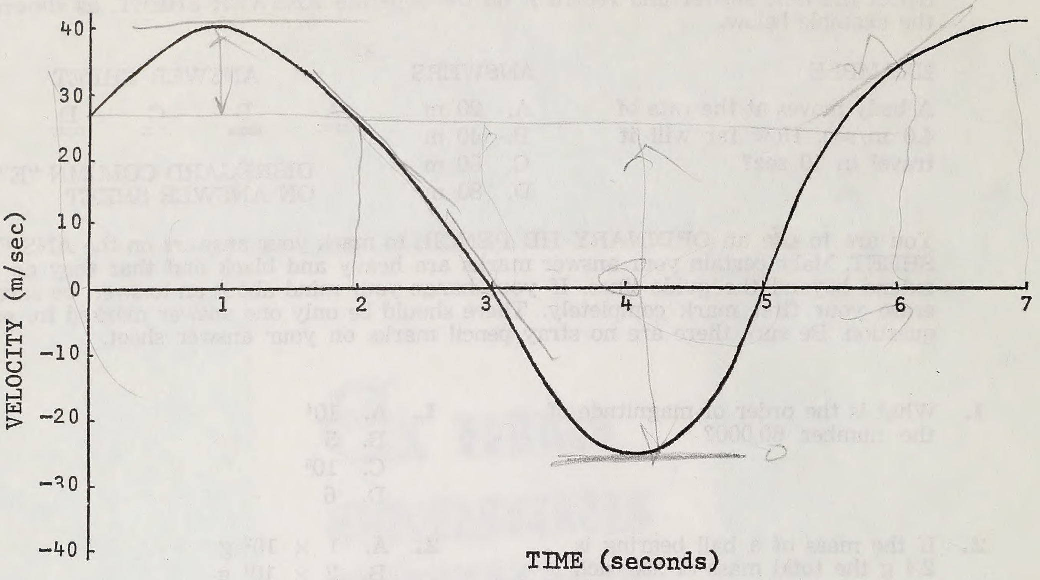
**2.** If the mass of a ball bearing is 2.4 g the total mass of six such balls should be expressed as

**2.** A. $1 \times 10^2$ g
B. $2 \times 10^1$ g
[✓ C.] 14 g
D. 14.4 g

**FOR ROUGH WORK**

**(No marks given for work in this space)**

Questions 3 - 5 relate to the following graph and information.



The graph represents the velocity of a body, as a function of time, moving in a straight line on a horizontal surface.

**3.** The object is at rest

**3.**
A. at the 1.0 and 4.0 sec marks
[✓ B. at the 3.0 and 5.0 sec marks]
C. at the 1.0, 3.0, 4.0 and 5.0 sec marks
D. during the 7th second

**4.** The object reaches its maximum distance from the position it occupied ot the zero second mark at the

**4.**
[✓ A. 1.0 sec mark]
B. 3.0 sec mark
C. 6.0 sec mark
D. 7.0 sec mark

**5.** The maximum acceleration of the object occurs during the

**5.**
A. 1st second
B. 2nd second
[✓ C. 4th second]
D. 6th second

**FOR ROUGH WORK**

**(No marks given for work in this space)**

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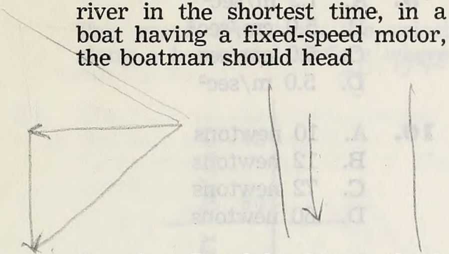
**6.** In order to cross a fast flowing river in the shortest time, in a boat having a fixed-speed motor, the boatman should head

A. straight across the river
B. at 45° to the river bank, downstream
C. at 45° to the river bank, upstream
[✓ D. at an angle to the river bank dependant upon the ratio of the speed of the boat to the speed of the river]



Questions 7 and 8 relate to the following information.

A body is projected horizontally out to sea from the top of a cliff. Air resistance is negligible.

**7.** The acceleration of the body during its flight is

A. increasing in magnitude and constant in direction
B. changing direction
C. constant in direction
[✓ D. constant in magnitude and changing direction]

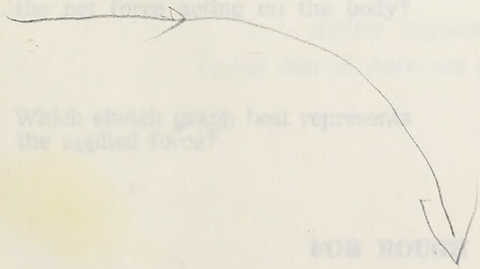
g

**8.** At the instant the object strikes the surface of the water it has a

A. velocity equal to that with which it was projected
B. speed equal to that with which it was projected
C. greater acceleration than it had at projection
[✓ D. speed greater than that which it had at projection]

**FOR ROUGH WORK**

**(No marks given for work in this space)**



$kg\cdot\frac{m}{s^2}$

**9.** A body of mass 1.2 kg is acted upon by a force of 6.0 newtons. The acceleration of the body is

$F=ma \quad a=\frac{F}{m}= \quad 6\,\frac{kg\,m}{s^2} \div 1.2$

**9.**
A. 7.2 m/sec²
B. 5.0 cm/sec²
C. 5.0 cm/sec
[✓ D.] 5.0 m/sec²

**10.** If an applied horizontal force of 60 newtons is required to keep a 6.0 kg object moving at 12 m/sec across a horizontal surface then the force of friction acting on the object is

**10.**
A. 10 newtons
B. 12 newtons
C. 72 newtons
[✓ D.] 60 newtons

**11.** Three forces, each with a magnitude of 6.0 newtons, act upon a body. The minimum net force on the body is

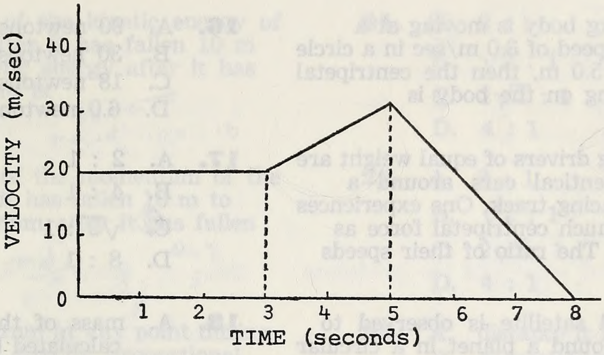
**11.**
A. 6.0 newtons
B. 2.5 newtons
[✓ C.] zero
D. 18 newtons

**FOR ROUGH WORK**

**(No marks given for work in this space)**

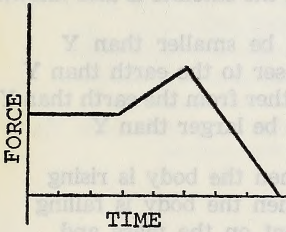
Questions 12 - 14 refer to the following graphs and information.

This graph represents the velocity-time curve for a body moving in a straight line along a horizontal surface where the frictional force is constant.



**12.** The shortest distance is travelled by the object during the

**12.** A. 1st second
B. 5th second
C. 6th second
[✓ D.] 8th second



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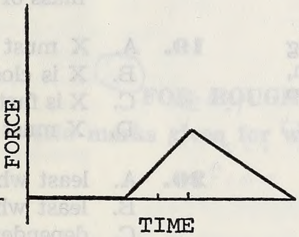

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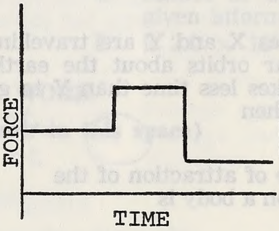

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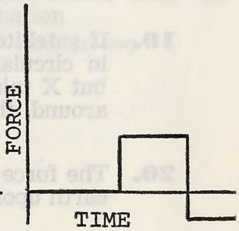

4.

**13.** Which sketch graph best represents the net force acting on the body?

**13.** A. 1
B. 2
C. 3
D. 4

**14.** Which sketch graph best represents the applied force?

**14.** A. 1
B. 2
C. 3
D. 4

**FOR ROUGH WORK**

**(No marks given for work in this space)**

**15.** If the length of a simple pendulum is halved then the period is

**15.**
[✓ A. increased]
B. decreased
C. unchanged
D. dependent on the mass

**16.** If a 10.0 kg body is moving at a constant speed of 3.0 m/sec in a circle of radius 5.0 m, then the centripetal force acting on the body is

$= \frac{mv^2}{r}$

$= \frac{10 \times 9}{5}$

$\sqrt{\frac{Fr}{m}}$

**16.**
A. 90 newtons
B. 30 newtons
[✓ C. 18 newtons]
D. 6.0 newtons

**17.** Two racing drivers of equal weight are driving identical cars around a circular racing track. One experiences twice as much centripetal force as the other. The ratio of their speeds must be

**17.**
A. 2 : 1
B. 4 : 1
[✓ C. $\sqrt{2}$ : 1]
D. 8 : 1

**18.** If a small satellite is observed to revolve around a planet in a circular orbit, then if the period and the radius of the orbit are measured the

**18.**
A. mass of the planet can be calculated but not the mass of the satellite
B. mass of the satellite can be calculated but not the mass of the planet
C. mass of both satellite and planet can be calculated
D. information is useless unless the mass of the satellite is also known

**19.** If satellites X and Y are travelling in circular orbits about the earth, but X takes less time than Y to go around, then

$v = \frac{2\pi r}{T}$

$2\pi r$

$T = \frac{2\pi r}{v}$

$2 = \frac{2}{1}$

$4 = \frac{4}{1}$

**19.**
A. X must be smaller than Y
[✓ B. X is closer to the earth than Y]
C. X is farther from the earth than Y
D. X must be larger than Y

**20.** The force of attraction of the earth upon a body is

**20.**
A. least when the body is rising
B. least when the body is falling
C. dependent on the mass and position of the body
[✓ D. dependent only on the mass of the body]

**FOR ROUGH WORK**

**(No marks given for work in this space)**

Questions 21 - 24 relate to the following information.

A 10 kg ball is dropped from a window 20 m above the ground and falls vertically with negligible air resistance.

**21.** The ratio of the kinetic energy of the ball after it has fallen 10 m to its kinetic energy after it has fallen 5.0 m is

E=F.d   F=ma   ma.d   1 : [illegible] 10

**21.**
[✓ A.] 2 : 1
B. $\sqrt{2} : 1$
C. $2\sqrt{2} : 1$
D. 4 : 1

**22.** The ratio of the momentum of the ball after it has fallen 10 m to its momentum after it has fallen 5.0 m is

[illegible]   a = 5

**22.**
A. 2 : 1
B. $\sqrt{2} : 1$
C. $2\sqrt{2} : 1$
D. 4 : 1

**23.** Its momentum at any point during the fall is directly proportional to the

**23.**
A. distance it has fallen
B. potential energy it has lost
[✓ C.] time it has fallen
D. kinetic energy it has gained

**24.** The impulse it will give to the ground upon landing

**24.**
A. is zero, because the ground does not move
B. is $2.0 \times 10^3$ joules
C. cannot be determined from the given information
D. is $2.0 \times 10^2$ newton-sec

**FOR ROUGH WORK**

**(No marks given for work in this space)**

Questions 25 and 26 relate to the following information.

A student pulled a heavy pendulum aside and measured its motion with a recording timer as it made one complete swing from left to right.

**25.** Upon appropriate calculation he should find that its velocity was greatest

**25.**
A. just as it reached the lowest point of its swing
B. just before it reached the extreme right position
C. a short time after it reached the lowest position of its swing
D. when it was ¼ of the distance from left to right

**26.** The potential energy of the pendulum would

**26.**
A. remain constant throughout the swing
B. increase when its kinetic energy increased
C. decrease when its kinetic energy decreased
D. decrease when its kinetic energy increased

- - - - - - - - - - - - - - - - - -

**27.** If two moving bodies have the same amount of kinetic energy but differ in mass

**27.**
A. the larger of the two must have the greater velocity
B. their momenta will be equal
C. the larger one will have the greater momentum
D. the smaller one will have the greater momentum

**FOR ROUGH WORK**

**(No marks given for work in this space)**

**28.** If a satellite describes an elliptical orbit around the earth

**28.** A. its potential energy is greatest when it is nearest the earth
B. its kinetic energy is constant throughout its orbit
C. its speed is greatest when it is nearest the earth
D. it will change to a nearly circular orbit after a few revolutions

**29.** The binding energy by which a body is held to the earth is equal in magnitude to its gravitational potential energy if the body

**29.** A. has zero kinetic energy
B. has enough kinetic energy to launch itself into orbit
C. has enough kinetic energy to escape into outer space
D. has the same amount of kinetic energy as gravitational potential energy

**30.** A pitched ball was struck by a bat. The ball reversed its direction so that it travelled at the same speed after it was struck as it did before. These facts indicate that the

**30.** A. bat was going faster than the ball when the two met
B. collision between the bat and the ball was perfectly elastic
C. bat had a greater kinetic energy than the ball before the collision
D. impulse given by the bat was greater than the momentum of the ball just before it was struck

**31.** If a container holds a gas mixture with molecules of two different sizes then both kinds of molecules will have the same

**31.** A. average kinetic energy of center-of-mass motion
B. total energy
C. average velocity
D. average energy of internal vibration

**FOR ROUGH WORK**

**(No marks given for work in this space)**

| | |
|---|---|
| **32.** If two samples of the same gas have equal volumes and equal pressures, but one sample has an absolute temperature twice as high as that of the other, then the | **32.** A. molecules of the hot sample are moving twice as fast as those in the cold sample on the average<br>B. densities of the two samples are equal<br>C. average kinetic energy of center-of-mass motion of molecules in the hot sample is $\sqrt{2}$ times that of molecules in the cold sample<br>D. cold sample contains twice as many molecules as the hot sample |
| **33.** When a parachute jumper has reached his terminal velocity, the rate at which heat is being produced by air friction is | **33.** A. negligible by comparison with other energy changes<br>B. less than the rate of loss of gravitational potential energy<br>C. the same as the rate of loss of gravitational potential energy<br>D. greater than it would be if he were at his terminal velocity while falling without a parachute |
| **34.** What is the average force exerted on a steel plate by a stream of 1.0 g bullets striking it and coming to rest? Assume that the bullets have a velocity of 500 m/sec and that 100 of them strike the plate every second. | **34.** A. $5.0 \times 10^{-3}$ newtons<br>B. 50 newtons<br>C. 0.20 newtons<br>D. $2.0 \times 10^{-4}$ newtons |

**FOR ROUGH WORK**

**(No marks given for work in this space)**

**35.** When a negatively charged rod is brought near a neutral pith ball, the ball is attracted. We can conclude that the pith ball

**35.**
A. is negatively charged
B. is neutral
C. is positively charged
D. may be positive or neutral

**36.** In a metal, the current consists of a flow of

**36.**
A. electrons only
B. electrons and positive ions
C. positive ions only
D. photons

**37.** Two large metal plates 0.10 m apart, are connected to a 100 volt battery. The force on a charged particle between them is $3.0 \times 10^{-14}$ newtons. If the separation is increased to 0.15 m, then to keep the force constant, the potential difference must be

**37.**
A. increased to 150 volts
B. decreased to 67 volts
C. kept constant
D. none of these

**38.** A, B and C are equal charges in a straight line, B being between A and C. The distance $AB = 2$ cm, and $BC = 1$ cm. The force on A due to B is $2 \times 10^{-6}$ newtons. The resultant force on B due to A and C is

**38.**
A. $10^{-5}$ newtons
B. $6 \times 10^{-6}$ newtons toward A
C. $6 \times 10^{-6}$ newtons toward C
D. $3 \times 10^{-6}$ newtons toward A

**39.** Two equally charged spheres repel with a force of $4.0 \times 10^{-3}$ newtons at a distance of 1.0 m. To increase the force to $8.0 \times 10^{-3}$ newtons, the distance between the charges must be made

**39.**
A. 0.50 m
B. 0.25 m
C. 0.71 m
D. none of these

**FOR ROUGH WORK**

**(No marks given for work in this space)**

**40.** A current of 2.5 amperes flows through a resistance of 10 ohms. The heat produced is

$P = RI$

$=10$

**40.**
- A. 25 watts
- B. 250 watts
- [✓ C.] 63 watts
- D. none of these

**41.** If a particle with a charge X is moving at right angles to a magnetic field Y with a velocity Z, then the force on it is proportional to

**41.**
- A. XYZ
- B. $\frac{XY}{Z}$
- C. $\frac{Y}{XZ}$
- D. $\frac{X}{YZ}$

**42.** A bright spot persists in the center of a TV screen due to electrons impinging on it. The N-pole of a magnet is placed below it. The spot will

**42.**
- A. move up
- B. move down
- C. move to one side
- D. remain stationary

**43.** The speed of electro-magnetic waves in vacuum

**43.**
- A. is equal to that of light
- B. is less than that of light
- C. depends on frequency
- D. depends on power source

**FOR ROUGH WORK**

**(No marks given for work in this space)**

**44.** A current is induced in a closed loop by rotating it about a fixed axis in a magnetic field. The strength of the induced current does NOT depend on the

**44.**
A. direction of rotation
B. resistance of the loop
C. strength of the magnetic field
D. speed of rotation

**45.** Which of the following do NOT belong to the electro-magnetic spectrum?

**45.**
A. TV emission
B. radar
C. ultra-violet
D. ultra high frequency sound

**FOR ROUGH WORK**

**(No marks given for work in this space)**

Values

In answering the following problems show your solutions in logical steps. When diagrams are drawn to scale, the scale used should be clearly indicated.

4 **46.** A uniform braking force is applied to a car, originally moving at 20 m/sec, for a period of 2.0 sec. If the car moved 20 m during the 2.0 sec to what was its speed reduced?

**USE SPACE BELOW FOR ROUGH WORK**

Values

6 **47.** A body is projected horizontally out to sea from the top of a cliff 125 m high. It strikes the surface of the water 100 m from the base of the vertical cliff. Calculate the initial velocity of the body.

**USE SPACE BELOW FOR ROUGH WORK**

## USE THIS SPACE FOR ROUGH WORK

Values

5 **48.** A pendulum consists of a 3.0 m length of rope with a 30 kg mass attached to the end. What is the speed of the mass as it passes through the lowest point of its swing if the tension in the rope at that instant is 550 newtons?

## USE THIS SPACE FOR ROUGH WORK

Values

8 **49.** A 2.00 g bullet fired vertically upward with a velocity of 500 m/sec struck a 0.200 kg plastic plate which was at rest at the moment it was struck and free to move in any direction without any restraining force. High speed photography showed that the plastic plate broke into two pieces when struck by the bullet and that one of the pieces which was later found to have a mass of 0.120 kg moved off at an angle of 30° above the horizontal with a velocity of 4.00 m/sec. The bullet came to rest when it struck. Find the magnitude and direction of the velocity of the other piece of plastic.

Values

6 **50.** A 1.0 kg block of wood starts from rest and slides for a distance of 2.0 m down a sloping board making an angle of 30° with the horizontal. It is found to have a velocity of 2.5 m/sec when it reaches the bottom. How many calories of heat are produced due to the friction of the sliding block?

**USE SPACE BELOW FOR ROUGH WORK**

Values

3 **51.** A uniform resistance wire 40 m long is connected to a 30 v battery. What is the potential difference between two points 3.0 and 15 m from one end?

4 **52.** An excess of $1.0 \times 10^{10}$ negative elementary electrical charges is placed on a small object. What is the electrical potential in joules/elem. ch. at a distance of 0.50 m from the object?

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